THE

AËRONAUTICAL JOURNAL.

A QUARTERLY ILLUSTRATED MAGAZINE DEVOTED TO ALL SUBJECTS CONNECTED WITH THE NAVIGATION OF THE AIR.

VOL. VII.

1903.

PUBLISHED BY THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN AND PRINTED BY KING, SELL, & OLDING LTD., LONSDALE CHAMBERS, 27, CHANCERY LANE, LONDON, W.C.

THE AËRONAUTICAL JOURNAL.

JANUARY, 1903.

The Aëronautical Journal.

(PUBLISHED QUARTERLY.)

SUBSCRIPTION PER ANNUM (post free), 4s.

Communications respecting Advertisements to be addressed to the Publishers, "Aëronautical Journal,"

Messrs. KING, SELL & OLDING, Ltd., Lonsdale Chambers, 27, Chancery Lane, W.C.

Editorial communications should be addressed to the Editor,

53, Victoria Street, Westminster, London, S.W.

NOTICES OF The Aëronautical Society.

AT a meeting of the Council of the Aëronautical Society held at the Society of Arts, John Street, Adelphi, on Thursday, December 4th, the following gentlemen were elected members of the Society:—

MR. ALEXANDER ANDERSON.
MR. J. N. MASKELYNE.
HERR JOSEPH HOFMANN.
MR. WILLIAM COCHRANE.
MR. FRANCIS HERNAMAN-JOHNSON.
MR. H. GRUNAU.

GENERAL MEETING.

The next general meeting of the Aëronautical Society of Great Britain will be held at the Society of Arts, John Street, Adelphi, in March or April next. Amongst the papers read will be one on "The Kite Equipment of the Scottish National Antarctic Expedition," by Mr. John Anderson (with Lantern Illustrations), "The Aerosac," by Mr. Patrick Y. Alexander, and "Observations and Experiments relative to Equilibrium in Air of a Body Heavier than Air," by Major L. S. Blackden.

INTERNATIONAL KITE COMPETITION.

There will be an International Competition for the Highest Kite Flight, under the auspices of the Aëronautical Society of Great Britain, in June next. The award will be the Silver Medal of the Society. The site selected will probably be on the Sussex Downs, and arrangements will be made for a general meeting of the Aëronautical Society to be held at the appointed place to witness the competition.

The following are the general rules drawn up by the Council of the Aëronautical Society of Great Britain:—

1. The Competition is for the highest flight attained by a single kite beyond 3,000 feet.
2. Duration of flight to be one hour, and kites must be sustained in the air during this period.
3. Each kite must carry a weight of two pounds.
4. The height to be determined trigonometrically from the ground.
5. The Competition is open to all ap-

proved by the Council of the Aëronautical Society of Great Britain, without limit of form of apparatus, and each Competitor must provide his own apparatus, winding gear, etc.

5. Each Competitor is to be held responsible for any damage or accident that might occur to or by means of his apparatus.
6. Members of the Aëronautical Society of Great Britain will have to pay no entrance fee, but for non-members there will be an entrance fee of half-a-guinea.
7. Not less than two Competitors can enter for the Competition.
8. The Jury will have the decision whether the Medal is to be awarded.
9. The decision of the Jury must be accepted as final.

In issuing these General Rules the Council reserve to themselves the right of making any additional regulation which may tend to facilitate the carrying out of the Competition.

Amongst those who have kindly consented to act on the Jury are—Sir Hiram Maxim and Dr. William Napier Shaw, F.R.S.

Members of the Aëronautical Society of Great Britain and others who wish to take part in the above Competition should communicate with the Honorary Secretary of the Aëronautical Society of Great Britain, 53, Victoria Street, Westminster, London, S.W.

CHANGE OF ADDRESS OF THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN.

Members of the Aëronautical Society of Great Britain and others are reminded that the new address of the Society is

53, Victoria Street,
Westminster,
London, S.W.,

and that all communications should be addressed to the Honorary Secretary at that address.

ERIC STUART BRUCE,
Honorary Secretary.

GENERAL MEETING.

The opening meeting of the new session of the Aëronautical Society of Great Britain was held at the Society of Arts, John Street, Adelphi, on Thursday, December 4th, 1902. The President, Major B. F. S. Baden-Powell, was in the chair

The President: Ladies and Gentlemen,—The Honorary Secretary will begin by reading you the minutes of the last meeting and also the report of the last session.

The Honorary Secretary read the minutes of the last meeting.

The Honorary Secretary: It is usual for the Honorary Secretary, on the occasion of the opening meeting of the session, to make some report as to the progress and work of the Society during the past year. As, however, we have a fairly substantial programme to get through this evening I propose to be as brief as possible and confine myself to merely stating facts.

1. As regards the finances of the Society during the financial year 1901-1902, our receipts, including the balance from the previous year, were £355 10s. 0½d. Our expenditure was £151 4s. 11d., leaving in hand on July 1st this year a balance of £204 5s. 1½d.

2. Regarding the membership of the Society during the last few years, this shows a steady increase year by year. We now have over one hundred members, and it is hardly necessary to state that a large proportion of these members are composed of those who are eminently distinguished in other branches of science, testifying to the value of aëronautics in widening the boundaries of scientific knowledge generally.

3. This year, for the first time in the history of the Society, first established in 1866, we have taken the step of settling down in premises of our own at 53, Victoria Street, Westminster, where will be the office and library of the Society. We are at present engaged in arranging the library at the new premises, and after it has been duly catalogued arrangements will be made for it to be open to members at stated times for reference.

4. I will say a few words about the work at the general meetings of last session. Several papers were read at our meetings of extreme value to the literature of aëronautics. Amongst them I may mention the paper by Sir Hiram Maxim on "Aërial Navigation by the Body Heavier than Air"; the paper on "Atmospheric Currents," by Mr. William Marriott; one on "Aëronautics in Germany," by Major W. L. Moedebeek; another on "Balloon

Photography," by Miss Gertrude Bacon, and a most able criticism on the late Senhor Severo's Airship by Dr. Carlos Sampaio.

5. At our concluding meeting of the session in July last, the Society passed a formal vote of sympathy with the Brazilian nation on the death of Senhor Augusto Severo in the cause of science and cosmopolitanism. On this occasion the Brazilian Minister, accompanied by the whole staff of the Brazilian Legation, was present. The vote of condolence was supported by Dr. Mills, the Secretary of the Royal Meteorological Society, on behalf of British meteorologists.

The reply of the Brazilian Minister was a philosophical commentary on balloon accidents, and might well be read and studied by those who, on account of a few mishaps, would disparage the study of aëronautics.

6. Amongst our plans for this new session on which we have entered to-day—a red letter one, for the fact that on it we have at last realised the return of our President amongst us, safe from the perils of the South African War—is the International Kite Competition to take place in June next, the award being the silver medal of the Society. In arranging this competition the Council hope they will have the co-operation of the members of this Society by an adequate response to the invitation to compete or be present. I will confine myself to mentioning two cogent reasons for endeavouring by this competition to stimulate the improvement of kites.

1. The kite is fast becoming a most valuable means of extending the boundaries of meteorology by giving facilities of observation in the free air at considerable heights.

2. The kite is, after all, the basis of what we, with reason, expect will be the future instrument of aërial navigation—the aëroplane. The more the surfaces of kites are improved so as to give greater sustaining power to the kite in the air, the nearer we shall be coming to the day when we shall sever the string and trust alone to the intelligence, motor, and propeller for balancing the aëroplane midst the diverse currents of the atmosphere.

Presidential Address.

RECENT AËRONAUTICAL PROGRESS, AND DEDUCTIONS TO BE DRAWN THEREFROM, REGARDING THE FUTURE OF AERIAL NAVIGATION.

By Major B. F. S. Baden-Powell.

It is with feelings of the greatest satisfaction that I am now able, for the first time, to address the Society in the capacity of its President, and I must sieze this opportunity of expressing to you my heartfelt thanks for the very great honour which you have conferred upon me by electing me to this position. I cannot but feel that my labours in the past, though varied and dipping into almost every branch of aëronautics, have not been so extensive or so prominent as to warrant my selection for this important post, but nevertheless, I sincerely hope that, with freer opportunities, I may, in the immediate future, be able to accomplish much more in the work we have before us.

My absence from England during the last three years, on active service in South Africa, has prevented my fulfilling many important duties for the Society during a period of unusual activity and importance, but on the other hand, the time I have spent on the "trackless veldt," and in the monotony of camp life, has not, I hope, been wasted, as ample opportunity has been afforded for careful meditation and consideration of the whole subject which it is the object of this Society to study. I therefore propose not so much to give a technical lecture on the various experiments of recent years—you have had better opportunities than I of studying these—as to endeavour to make clear our present position.

During these three years many great events have taken place in the aëronautical world. Count Zeppelin's monster air-ship, built on sound scientific principles, of enormous size and quite different in design to anything made before, has been completed, and has made successful ascents, although, I much regret to have to add, has not succeeded in travelling through the air at a sufficient speed to warrant its being considered a practical success.

Then we come to M. Santos-Dumont's many more or less successful trips in his navigable balloons, which, if not demonstrating any new principles, has shown what perseverance and attention to detail can achieve. Though we have learnt some useful practical lessons, and have been given data of great value for future experimenting, unfortunately the actual results attained carry us so little beyond what was accomplished twenty years before by MM. Renard and Krebs, that one begins to think whether we have not nearly reached the end of the tether as regards the propulsion of balloons.

The unfortunate calamities to M. Severo's and more recently to M. de Bradsky's balloons, as well as the absolute failure of M. Roze and others, only tend to confirm this growing opinion. The latest accounts of M. Lebaudy's balloon seem to make out that it has accomplished more, but we must await the results of more prolonged trials before we can come to any decision. Mr. Stanley Spencer's trip over London in a navigable balloon, though it proved nothing as regards the dirigibility or inherent speed of the machine, attracted some interest in the matter.

Besides these we have heard of various experiments with flying machines proper. Herr Kress

is said to have risen off the surface of the water, but owing to some mismanagement the machine turned downwards and fell in the water again. In Australia Mr. Hargrave has constructed a large machine. In America, Mr. Wilbur Wright and his brother have been making wonderful progress with gliding machines, and Professor Langley has been hard at work constructing a large new machine. He informed me the other day that in a very short time we might expect to hear something of this—something big. It might, he added, be a big smash! But he wisely intends trying it over water.

Then, too, like the invisible universe of dark stars that Sir Robert Ball talks about as being possibly more extensive than that of those seen, there are probably more inventions being worked at in private than we ever hear of publicly, and many of them are doubtless of great importance. It is only recently that the results have been published of the valuable experiments with aërial screw propellers which Mr. W. G. Walker conducted for Mr. Alexander.

Another sign of progress in the subject of aëronautics during the last few years has been the establishment in England of two more public bodies, the Aëro Club and the Aëronautical Institute, the former having been established for the encouragement of ballooning (and possibly flying) as a sport, while the latter aims at interesting the working-classes in the subject.

I may here seize the opportunity of explaining to our visitors and others the objects of our Society, and why it is that we make so much of a study which to them may seem somewhat chimerical and of no very special merit, and by explaining these I hope to enlist their sympathy and support to the movement. For I have before now been asked, "Why should it be necessary to have a society for the study of aërial navigation? Where is the importance of it? Why not institute a society for submarine navigation, for wireless telegraphy, or for the encouragement of any other novel invention for the improvement of means of communication or warfare? But useful as many such inventions may be, none can have the great importance which may some day be attached to the machine which navigates the air.

And there are two reasons why this subject is a large one. The first is that the science of aëronautics is one combining many branches and spreads into many ramifications. We have aërial machines as they exist to-day. The balloon, forming a unique and fascinating mode of travel, enabling us to mount high into the skies to obtain glorious views of earth and cloudscape, giving us a laboratory for the study of many intricate problems of the atmosphere, and forming a valuable instrument of war. We must study how this passive buoy may be improved upon, what new materials may be applied to its construction, gases, methods for causing it to rise and sink, and means of directing it out of the course of the wind. But we also have the more difficult problem of how to drive it through the air so as to make it independent of the wind and go in any desired direction. Closely connected with this is the subject of kite-flying, whether for man lifting or meteorological observation, of parachutes, and of soaring machines. All these necessitate a certain knowledge of the various branches of meteorology, which is to aëronautics as hydrography is to marine navigation. Then we have the study of birds and other flying animals as a natural sequel to the science.

The second reason for the importance of this subject is the vast future which appears open to it. If such an apparatus can be constructed as will enable man to make practical use of the highway of the air, there is promise of the subject becoming of even more importance than marine navigation or railways.

We have then not merely to consider the broad principles of the general form of the aërial machine of the future—whether it is to take the shape of an artificial bird, a propelled kite, or a dirigible balloon. We have to study the subject of aërodynamics, the effect of air pressures on plane or curved surfaces travelling at various speeds and at various angles of incidence. We have to investigate the efficiency of aërial propellers of different forms, the strengths of materials, the energy and weights of various forms of motors. Then we must also study the natural currents of air, the variability of air strata, the trends of winds, and so on.

The great range of subjects to be gone into by our Society is thus patent. Many of our members and others are busily at work in some particular groove making steady progress in building up their portion of the foundation of that great structure which we all hope to see rise up in the future.

But, to return to the question of the recent progress in Aërial Navigation, I will now endeavour to point out and explain the present position we hold, and by considering the state of the subject as it at present exists, to judge whether or not there is any real probability of our attaining that great goal which most of us look forward to.

Though it is improbable there are many here present to-night who do not look forward with feelings of confidence that artificial flight will some day be accomplished, yet there are still some few sceptics (most, if not all, of whom have never looked deeply into the subject), who believe it impossible. For this reason it may not perhaps be out of place, in such an address as this, to point out our reasons for maintaining this belief.

The first great argument in favour of it is that birds fly. If we had never seen such a thing as a bird, many of us might reasonably argue the thing to be impossible. But there they are. Not only can they rise in the air, not only progress at a very rapid rate through it, but they can continue the movement for long periods and in almost any weather. It is quite certain now that birds do not possess any very extraordinary power; but if they did, we could probably "go one better" with the modern very

compact and light oil-engines. We have now compressed the strength of a horse into a little motor weighing no more than a large bird. There is the power. Can it be applied? Many people have argued that the flight of a bird is dependent on some valvular action of its feathers. Let it be so, but how do you account for the flight of the bat, and of the flying-fox? Others have thought that flight is only possible up to a certain weight, maintaining that the ostrich and the emu are beyond that limit. But geologists will point you out the fossil remains of a huge reptile which they declare flew in the air and weighed far more.

But leaving Nature, we may consider what has been done by man to justify our hopes.

Though I believe it may be said that nearly all the authorities on the subject are now of opinion that the balloon cannot be considered as much more than an aid, to act as a stepping stone, to true flight, yet there are many workers who consider that very much may be accomplished by propelled balloons. Some authorities have calculated that a speed of 44 miles an hour might be practically attained, but not more.

M. Santos Dumont and others have shown us what can be done with a little cigar-shaped balloon. They have clearly demonstrated the difficulties to be overcome. It is very palpable that the surface of such a balloon must be stiff and rigid. Once it gets flabby it cannot be propelled, the skin will vibrate and add to the resistance, the nose, unless distended by framework, will be driven in and offer great resistance, the gas will be driven back towards the after end, and the balance be disturbed. To preserve this necessary rigidity all the earlier navigable balloons were kept taut by means of the ballonet, but Count Zeppelin effected this by an internal framework.

Count Zeppelin, as I have said, struck out a new line. By greatly increasing the size of the balloon, he had obtained so much more lifting power as to be able to add a complete framework that stiffened it. But it was probably solely owing to this great size that the apparatus failed to be practically manageable. It may be compared to the *Great Eastern* steamship, but with the difference that at the time of its construction we had but the most elementary experience of air vessels propelled by engines. At the same time this enormous capacity had its advantages. Had it been of half the diameter and half the length, though the resistance to propulsion might have been only one quarter, the volume and the lifting power would only have been one-eighth. So that, instead of carrying engines of 32-horse power as was done, it might have only been possible to carry some of 4-horse power! Dr. Pole in his most valuable little treatises years ago pointed out the advantages of very large volume.

One result, then, of recent experiments is that it seems quite practicable to build a navigable balloon to go, we will say, 15 miles an hour. This, however, is not quite enough. As the wind so often blows faster than this it is unsafe to let the balloon out on any but a very calm day, else, though only blowing 16 miles an hour, the machine will inevitably be carried off and have to descend in strange fields far from its shed and the difficulties of transporting it back may be so great that it may even have to be taken to pieces. Having successfully accomplished this much, however, it certainly looks as if we could improve a little, and get the balloon to travel 20 or 25 miles an hour, which would be sufficient to stem the ordinary light breezes.

We have learnt many practical lessons from these recent experiences. It is necessary to make efficient provision against the balloon caving in or buckling up. It is, of course, most important that the engine shall be so constructed as not by any possible means to be able to ignite the gas in the balloon. But especially we have learnt that, speaking in general terms, for a cigar-shaped vessel some 20 ft. in diameter it is necessary to apply a power of more than 16 horse-power (presuming no exceptionally efficient propeller be found) for it to be really efficient. This practically means that you must have a larger balloon.

MM. Lebaudy have now adopted a larger balloon enabling them to carry an engine of 40-horse power, or more than double the power of that of M. Santos Dumont. Col. Renard also, is about to build one larger still, of some 90,000 cubit feet. Dr. Barton's proposed airship is also designed to be of great size.

Passing from the balloon, that is to say any apparatus which displaces a volume of air weighing as much as or more than its own weight (and many thoughtless inventors are apt to neglect this definition) we find several different types of machines which show promise of success.

Beginning with the simplest, we have the gliding or soaring machine. One of the greatest paradoxes in Nature is soaring flight. I have said how doubtful many people might be about aërial navigation if they had never seen a bird fly, but we can confidently assert that no man would believe it possible for a bird to maintain itself for hour after hour in mid-air without the slightest movement of its wings, were the actual demonstration of it not visible every day. I will not now enter on a discussion as to how this is accomplished, but will only say that there are inventors who hope to be able to emulate the albatross, and soar away into the heavens without any motive power or propeller. It seems so paradoxical that many laugh the idea away. But the hard fact remains that birds can do it, and, therefore, why not men? I received a letter only a few days ago from Mr. O. Chanute, than whom there is probably no greater authority living on soaring flight. He says that he had just returned from witnessing this season's gliding experiments of the Brothers Wright, and that "they have made a very considerable advance since last year, and now glide at angles of 6° to 7°, sustaining 125 to 160 lbs. per *net* horse power. Wright is now doing nearly as well as the vulture, is not far from soaring flight, and I am changing

my views as to the advisability of applying a motor."

I think this is a most remarkable statement, and there really seems no reason why such experts, having attained proficiency in the delicate art of balancing themselves according to the various puffs and currents of air, should not be able to soar away on the wings of the wind and remain indefinitely in mid-air!

The next general type of apparatus that I may refer to is that of rising in the air by means of a screw propeller mounted on a vertical shaft. We all have seen little toys ascend in the air working on this principle. A large machine of this sort was recently constructed in Paris, but the experiments of Mr. W. G. Walker, of carefully testing the thrust and lifting power of various screws, have been among the most important contributions to this science. He has clearly shown that it is possible to practically obtain a thrust of 25 lbs. per horse power. As engines are now made weighing no more than 10 lbs. per horse power, it is clearly demonstrable that a machine on this principle could be constructed to lift itself, carrying some 15 lbs. per horse power over and above the weight of the engines. Even if not a practical form of machine for travelling through the air, it would be a most interesting experiment to try.

Finally, we come to that variety of aërial machine which has been adopted by most inventors and which seems to promise the most satisfactory results. I mean what is known as the *Aeroplane*. Sir Hiram Maxim brought this prominently forward many years ago, and both he and Professor Langley have proved theoretically that it is the most economical form of apparatus, that is to say, that a given weight can be supported with less engine power than by other methods.

Great progress had also been achieved in recent years in this line. Libienthal pointed out the greater efficiency of curved surfaces as compared to flat ones. Phillips and Hargraves experimented further with aërocurves. Considering how much more we know about the subject now than when Maxim first built his machine, it looks as though we might really hear of great results shortly from America or Australia.

Our present position is, then, a hopeful one. Balloons have been gradually improved until we can practically rely on building one to go 15 miles an hour, and probably more. Large flying machines, giving practical experience of their construction, have been built. Good sized models have flown well through the air. Gliding machines, balanced and controlled by human effort, have been maintained in the air for considerable periods, and have descended at very gradual angles. And, what is of the greatest importance, small engines, giving great power for their weight, have steadily improved year by year, leaving but little for us to desire in this respect.

All that we require, then, to attain practical flight, is to make a machine only slightly better than those already in existence. To accomplish this all that is required is a certain amount of skill, and a good deal of money.

There has often been a lot of wild speculation about what might happen when flying machines are introduced into everyday life, but it may be worth while considering for one moment what is likely to result, so as to judge whether the matter is one really demanding an effort to accomplish, whether, in fact, "the game is worth the candle."

Whatever the exact form the apparatus may take, we may assume that it will possess certain characteristics. The first of these is that it will travel *very fast*. There are several reasons for supposing this. Not only *must* it be able to stem ordinary light breezes, but to be really useful it should be capable of going against any ordinary wind, and to do this at any useful speed implies a rate of 40 or 50 miles an hour. Then, high speeds are economical in aërial machines. Langley, by his elaborate experiments, has shown that the faster our aëroplane is propelled through the air the less force in proportion is required to sustain it. Again, the air-ship, unlike its prototype on the water, is not impeded by skin friction, so that the power required to drive it at high speeds does not increase in the same proportion. A bullet can be propelled through the air at immense speed, but if it enters the water its way is soon stopped. One more reason why we may hope for greater speeds than are usual in travelling on land and sea is, that in the latter, pace must be kept within bounds for fear of collision, both with other conveyances and also with irregularities (whether in rails, embankments, and ridges, or rocks and sandbanks) which may exist beside the track.

In the aërial highway we have greater latitude. We have height as well as length and breadth. We can choose our particular altitude and stratum to travel in, so that perhaps 1,000 machines could cross over the same spot at the same time without colliding. In fact, it would decrease the chance of collision by one-thousand fold, in addition to the lateral route not being so circumscribed. There are no police traps up there!

Taking into consideration the speed at which birds travel, that at which models have been flown, and the theoretical calculations which have been made, we may reasonably suppose that a hundred miles an hour will be no excessive speed for a flying machine.

Those who think this estimate over-sanguine may ponder over an extract I recently came across, from an old newspaper published 78 years ago, referring to the railway then about to be constructed from London to Woolwich. In this reference is made to the possibility of the train being able to attain the terrific speed of 18 to 20 miles an hour; but it concludes, with sarcastic incredulity, "We should as soon expect the people of Woolwich to be fired off on one of Congreve's rockets as to trust themselves to the mercy of such a machine going at such a rate."

Once a practical flying machine existed, the

uses to which it might be applied are varied and important.

Primarily, it would form an incalculably valuable engine of war. One can scarcely imagine any invention which could have a greater effect on the conduct of warfare.

We can now appreciate, much more than we could three years ago, of what vast importance such a machine would be. It is worth dreaming for a moment to realise what might have happened had we in 1899 had some machine capable of travelling rapidly through the air. First of all, for mere reconnoitring, how much could have been done! In Natal, on the outbreak of war, such a vessel, ascending at Ladysmith, could have cruised around up to Laing's Nek, noting every Boer and every gun within, say, five miles of the track passed over, taking a turn round along the frontier, and have been back to report within a few hours. We would then, at "one fell swoop," have had certain, reliable, and full information of what was doing, instead of going on mere rumours and the vague observations of a few scouts. Another machine at Orange River could have moved forward, noted the position of the enemy at Belmont, Modder River, and Magersfontein, could have gone into besieged Kimberley and heard their news, and could have run back to report to Lord Methuen. I need not repeat the many instances that occur to me of the extreme value of such an apparatus for reconnaissance. We might really say that *none* of those awkward reverses which we suffered in the early part of the war would have occurred had we known the exact whereabouts of the enemy. Latterly, how easily the evasive commanders could have been located and followed up. Reconnaissance by captive balloon may be considered dangerous, but an apparatus travelling 150 feet a second runs an infinitely smaller chance of being hit by projectiles. If the dropping of explosives on the heads of an enemy is not now considered "fair play" (though it is difficult to see why this should be less humane than throwing lyddite shells from a howitzer), yet there are many more uses to which the aërial fighter might be put.

He could blow up the railway lines and bridges, even if he had to descend to do so. He could cut all the telegraph wires in the country, and could set light to stores and do other damage. A machine soaring about over a town or camp occupied by the enemy would certainly have a very decided moral effect on him. Communication could be kept up with, and even, perhaps, a few stores introduced into a besieged place.

I need not go further into the possibilities of the future. The more we think the matter over the more can we realise the extraordinary effect such an innovation would produce in war. I do not think anyone would deny that, had we been in possession of such apparatus during the late war, the operations would have been so greatly facilitated that the campaign would have been ended in a comparatively short time, and that we should have been saved an expenditure of many millions of pounds.

Even in naval warfare, if such speeds as I have mentioned were possible, the aërial machine should prove of infinitely more value than a submarine or a torpedo boat. If the invention of the Brennan torpedo was considered worth £110,000, how much more would be the value of a dirigible aërial torpedo!

Another important purpose to which flying-machines could be applied would be for the exploration of unknown lands. With a rapidly-travelling apparatus, the North Pole could be reached in a few hours. From the north of Norway it is about 1300 miles to the Pole. It would then be almost possible to go there and back in 24 hours! When we think of the large sums which have been devoted to Arctic and Antarctic explorations, and remember that very possibly a tenth of this amount might produce a machine capable of thoroughly exploring both these regions in a few weeks, it seems really worth considering whether such money is not wasted. The trackless deserts of Asia and Africa could be traversed and re-traversed, the mysteries of Mecca and of Lassa laid at our feet.

But over and above these most important and far-reaching possibilities of aërial navigation, there is the likelihood of a revolution in our ordinary modes of travel by one infinitely more rapid, cheap, and convenient. I have already given my reason for supposing that such a means of travel would be rapid. There is also good reason for supposing it would be economical. No rails or permanent way need be laid on the billows of the clouds. No roads need be constructed or kept in order through the realms of blue. Even expensive harbours, dredged channels, lighthouses and beacons, need not be maintained by the owners of airships. Going from place to place "as the crow flies" shortens the route and adds to the economy. The *convenience* of the system is also evident. Already we are beginning to appreciate the value of the motor car going from door to door, instead of our having to get to the train at a fixed moment. But when we can order round our aërial motor to take us straight to our destination, passing equally well over land or water, towns or cornfields, independent of traffic and roads, then only shall we realise what real convenience of travel is.

Speed, economy, and convenience are big factors in a new mode of travel.

But there is one consideration, which I believe is greatly responsible for the tardiness with which this subject progresses. Perils and dangers loom before us as a skeleton contaminating and haunting our castle in the air. The mere idea of being poised high up in the sky, and of falling from the machine through thousands of feet to Mother Earth, is so terrible to contemplate. But the aëronaut of to-day soon gets accustomed to being at a giddy height, and without doubt the people of to-morrow will have no qualms. Imagine the feelings of the savage who for the first time sees an express train rush through a station at 60 miles an hour, banging and clattering with fiendish uproar,

shaking the very ground, and darting along at a speed incomparable to anything he has ever seen before. Would he trust himself to travel by that means? Though to flit through the air with the speed of a swallow may seem highly dangerous to our inexperienced minds, how often do we see a bird fall headlong to the ground?

What we see, then, looming in the future, more or less near, according to the energies of, and the encouragement we give to, those pushing the matter forward, is the introduction of a new invention forming an invaluable and all-powerful weapon of war, an important aid to science and the practical knowledge of our globe, and a speedy, economical, and pleasant mode of getting from place to place, such as will probably completely revolutionise our present methods of travel. Is this to be hastened and encouraged? If so, how can we help to further the cause? Like most matters in this world, what is most wanted is money. Many clever inventors and engineers are quite ready with their plans, but have not the means to complete them. We see millions of pounds spent on equipment for war. Hundreds of thousands devoted to the building of small warships. We see thousands subscribed for geographical exploration. But for the encouragement of that invention which may be paramount over all these, we see practically nothing devoted. When I say "practically nothing," I am not forgetful of a certain few who have devoted much to this cause. We do not forget the very generous donations which Mr. Alexander has given to this Society, nor the valuable time and energy which our worthy Secretary has devoted so gratuitously to further the objects of the Society. Others, too, are helping as best they can with limited time and money; but what we would like to see would be a real solid fund built up, such as would enable us to get really useful work done. Then I feel sure it would not be long before the British nation would owe a debt of gratitude to the Aëronautical Society of Great Britain. (Loud Applause.)

Contributions of Balloon Investigations to Meteorology.

By Dr. William Napier Shaw, F.R.S.

In bringing to the notice of this Society the obligations under which Meteorology has been placed by those who have ventured themselves into the upper air, or who have devised and carried out plans for the exploration of the upper regions with self-recording instruments, I do not propose to give an exhaustive view of the subject. To do so would require more leisure than the exigencies of a more or less laborious office allow; but no one who is interested in the progress of Meteorological Science can fail to form some estimate of the valuable results which have been already obtained by the organisers of researches in the upper air, nor to speculate upon the still more valuable results which further prosecution of such researches may be confidently expected to yield in the future. Such speculation as to the future is particularly natural to any one who has to deal with the Meteorology of various parts of the British Empire; for it must be admitted that if any Meteorologist were invited to take a map of the world and put his finger upon the spots where the investigation of the upper atmosphere would seem to be most interesting and most urgently demanded, he would point first of all, perhaps, to some part of the ocean as being free from the perplexing uncertainties attaching to land observations, and, if restricted to *terra firma*, he would select the Eastern shores of the North Atlantic Ocean, the nearest shores to that great atmospheric laboratory, the generating station of travelling depressions; to the peninsula of India, the home of the monsoons, the most characteristic of the settled phenomena of periodic atmospheric change; and to certain remote islets in the wide oceans for the investigations of the general laws of the interchange of air over the ocean surfaces.

But who should investigate the upper atmosphere over the sea if not the greatest maritime nation on the earth; and when at the same time that nation possesses the most western outposts of Europe on the shores of the North Atlantic Ocean, when it controls the Indian peninsula, and when the remote islets where observations are desirable also fly the Union Jack, there seems good reason to express surprise and possibly some other emotions that the British nation is at present contributing hardly anything to an investigation that is so actively pursued in France, in Germany, in America, in Russia, and in Austria under conditions of far less cogency than apply in our case.

It is true there are difficulties. I do not suggest that the open ocean or a remote islet is a suitable place for ballooning. Our own islands are small enough to present difficulties and even dangers. On that account and on others the investigation is expensive; and though the results may be scientific, to be quite frank, there is no guarantee that they will be of immediate public utility. But if you allow me without protest to tell you that the difficulties, whatever they are, are such as British enterprise and British pluck cannot overcome, and that the expenses are such as British poverty cannot

afford, I shall take your acquiescence merely as an example of undeserved tolerance that I do not think you would extend to one of our neighbours across the seas if he were so rash as to express the same opinion. In that case you would, I feel sure, wish to find other and more cogent reasons for our inaction in such a matter or take the alternative course more natural to a Society devoted to Aëronautics and demonstrate the contrary with appropriate vigour.

I am, however, wandering from my subject. I wish to say that I am intending to limit myself to-night to those aspects of the investigations which have struck me in the ordinary course of my work without making any very special study.

First, there are many things in meteorological records of which we can give no sufficient explanation. Let me give you an example. This slide shows the recorded phenomena during a thunderstorm on July 27, 1900. You will notice very curious variations in the barometer curve and associated rainfall and other changes. These changes probably represent a very turbulent state of the atmosphere with great vertical displacement of air. Balloon observations confirm the hypothesis of turbulence, but they have not given sufficient quantitative results to afford an adequate explanation. I will cite a description of a balloon voyage in a hail storm by Prof. John Wise, the well-known American aëronaut, on June 17, 1843, taken from "Blasius on Storms," p. 141, which gives a thrilling account of the turbulent motion experienced.

Such experiences are perhaps too hazardous to be intentionally repeated and the description is too general to go further than to indicate a possible relation between the turbulent state of the atmosphere above and the instrumental change at the surface.

My next example of general observation is a picture of the upper development of a cumulus cloud taken from the magnificent publication of the Aëronautical Society of Berlin.

Mr. Bacon could probably add many other examples of contributions to what I may call descriptive Meteorology from the favourable point of view above the lower clouds afforded by balloon voyages.

Among the subjects of observations with instruments in balloons the most conspicuous are the determination of the vertical distribution of temperature and humidity. Some results as to the general direction and force of winds have been obtained, and observations of solar radiation and of electrical potential difference have been undertaken occasionally, but not to the same extent as observations of temperature and humidity. Without following any particular order, I propose to group what I have to say under the following heads:—

(1) The British Association inquiries conducted by Welsh and subsequently by Glaisher;

(2) The observations of M. L. Teisserenc de Bort at Trappes;

(3) The German establishment at Berlin;

(4) Mr. Rotch's Observatory at Blue Hill—and to add some other observations.

The British Association has taken up balloon investigations for meteorological purposes on at least two occasions—in 1852, when Mr. Welsh carried out four ascents for the Kew Observatory Committee of the Association in Green's Nassau balloon; in 1862 and 1863 when Mr. Glaisher made thirteen ascents for a special Committee of the Association in Coxwell's Mammoth Balloon. Last year the Association returned to its old enterprise and appointed a Committee to co-operate with the Royal Meteorological Society in the investigation of the upper air by means of kites.

Welsh's results are represented in four excellent plates included in the Philosophical Transactions of 1853. They show observations up to a height exceeding 22,000 feet and the corresponding temperature and humidity.

The instruments employed were a siphon barometer, two pairs of wet and dry bulb thermometers, one pair being provided with means of aspiration, for causing a continuous current of air to pass over the bulbs, the other pair free, and a Regnault's hygrometer. The purpose of the aspiration arrangements was to avoid or at least to diminish the effects of solar radiation upon the readings of the thermometers. The results are similar in general form to those obtained by later observers, of which I hope to show you some reproductions on the screen. The temperature differences are approximately:

$(72° - 10°) = 62$ for 19,400 feet.
$(68° - 15°) = 53$ for 19,000 feet.
$(60° - 27°) = 33$ for 12,500 feet.
$(50° - 2°) + 48$ for 22,500 feet.

The humidity results are peculiar in that they show as a rule very considerable divergence from saturation when the observations are taken in actual clouds. To this point I shall return later on.

Glaisher's results for his thirteen ascents are given in the Reports of the British Association for 1862 and 1863. His instruments were generally similar to Welsh's, but after breaking the aspirated thermometers he discarded the use of the aspirator and trusted to

polished metal screens for the protection of his thermometers against radiation. He also carried with him electrical and optical apparatus as well as ozone papers.

I give on the screen a general representation of his results for temperature, which have remained until quite recently the ultimate authority for the accepted numbers expressing the average vertical temperature gradient. From the slope of the curve you will see that the tendency is towards a limiting minimum temperature at heights within the reach of balloons.

The interval between Glaisher's observations and the more recent ones to which I shall allude is chiefly conspicuous for the development of portable self-recording apparatus. With purely mechanical multiplication very delicate aneroids, thermometers, and hair hygrometers, particularly by the well-known firm of Richard Frères, of Paris, are made to read the pressure, or height, the temperature, and humidity upon a revolving drum, and this instrumental development has given rise to extensive use of unmanned balloons and kites for meteorological purposes. The manned balloon is, of course, an indispensable adjunct as furnishing a means of comparing the indications of these self-recording instruments with the eye-readings of standard instruments similarly exposed; but I shall now turn your attention to results obtained by the other type of instrument, the self-recording, as distinguished from the eye-reading instruments used by Welsh and Glaisher.

M. Teisserenc de Bort's establishment at Trappes, near to Paris, is a laboratory of Atmospheric Physics on a large scale. Balloons of all kinds and kites of the highest lifting capacity are constantly employed in making observations.

The representative diagram from this observatory, which I shall shew you, gives the temperature of the air over Paris for a continuous period of six weeks in the early part of 1901.

By way of supplement to this I place before you a corresponding diagram of the hourly variation of temperature over Berlin from a series of ascents made at the aëronautical establishment there by the balloonkite, a monstrous instrument which is inflated with gas and yet keeps its equilibrium in a wind when it is held captive. For this I exhibit also a reproduction of the actual record showing the long duration of the ascent of the balloonkite.

I have introduced these diagrams as falling naturally into comparison with that by M. Teisserenc de Bort without any account of the institution that furnished them. But I now repair that omission by calling attention to some points in connection with it. It is a very fully equipped establishment upon the Tegler Schressplatz, near Berlin, and is, at the same time, the most active centre for the investigation of the upper air. Its best known aëronauts, Berson and Süring, have accomplished the most adventurous ascents in free balloons. Its unmanned balloons have reached the unexampled heights of upwards of 60,000 feet, while its balloonkite and its Hargrave kites are continually exploring the more accessible regions of the atmosphere.

Two years ago it contributed three magnificent volumes of results of the investigations carried out under its auspices entitled *Wissenschaftiche Luftschiff fahrten*, and recently it has published an additional volume of results of the more recent experiments. From these volumes I have already taken the illustration of the development of cloud above the first cloud layer and the diagrams representing the results of the kite balloon observations. I will now exhibit some additional diagrams taken from the same source.

The first shows the temperature results at Berlin compared with Glaisher's results, and the second, a comprehensive summary of the results of the Berlin observations for vertical temperature distribution at different seasons.

With regard to this question of temperature, it will be remembered that the inference from Glaisher's observations was that the temperature approached a limiting minimum at a comparatively moderate height. This conclusion was questioned by Berson and the other Berlin investigators, who found no indication of a slackening of the fall of temperature, indeed, rather the reverse; but on prosecuting the researches in still higher altitudes the indication re-appears. At the Aëronautical Congress at Berlin in May last, M. Teisserenc de Bort expressed the opinion (quoted from Mr. Rotch's report in the *Monthly Weather Review*) that in the layer between 8,000 and 9,000 metres (26,000 to 30,000 feet) the decrease of temperature becomes slower, ceasing entirely at 11,000 metres (36,000 feet); above that height a warming may set in with fluctuation of 1 to 3 C., making the temperature on the average nearly constant. In the summer this isothermal is higher between 13,000 and 14,000 metres, lower during the prevalence of depressions, but 4,000 metres higher during a high pressure. These results are confirmed by the more recent results observed at Berlin, from which it appears that

above 10,000 metres (33,000 feet) temperature oscillates and does not appear to decrease, although beyond the variable stratum at 17,000 metres (56,000 feet) and recently as high as 19,500 metres (65,000) feet), the temperature was again found to decrease so that the possibility of an absolute minimum of temperature is by no means excluded.

Among the services rendered by the Berlin establishment must be reckoned some important contributions to our knowledge of the conditions requisite for obtaining accurate meteorological measurements, particularly of temperature. The exposure to radiation in the upper atmosphere makes the observations of temperature particularly liable to error. A great step in advance is marked by the introduction of the convenient ventilation psychrometer the invention of Dr. Assman, the chief of the Berlin establishment, but accuracy in measurement requires not only suitable instruments but suitable mounting in, or rather outside, the car of the balloon to avoid the influence of the body of the balloon itself. Dr. Assman also claims our thanks for having introduced for the purpose of automatic reading a self-recording instrument for pressure and temperature without clockwork, which is a considerable item in the weight to be carried by an unmanned balloon. The motion of the drum, or rather disc, carrying the paper is actuated by the temperature changes, while the aneroid needle records on the disc the corresponding atmospheric pressure, and there is thus recorded a curve of direct relation between temperature and height without any time record. This arrangement reduces recording gear to the minimum weight, and it is used by Dr. Assman in conjunction with unmanned rubber balloons which are allowed to expand as they rise and ultimately burst, leaving the instruments to be carried down by a parachute. In this way enormous heights are comparatively easily attained.*

To the investigation of the behaviour of instruments the international simultaneous balloon ascents have largely contributed. These are held on the first Thursday in each month and ascents are generally undertaken with them at Paris, Berlin, Strasburg, Vienna, St. Petersburg, Blue Hill, U.S.A., and now in Italy. The ascents may be either of manned balloons, ballons-sondes, or kites, and for these ascents a special form of self-registering thermometer, introduced by M. Teisserenc de Bort, is prescribed. While in consequence of the difficulty of recording accurate temperatures in a floating balloon in sunshine it is suggested that ballon-sondes should be sent up an hour before sunrise.

I have incidentally mentioned Blue Hill. I ought to point out that the observatory under the direction of Mr. Rotch is largely responsible for the development of kite investigations. I give one of the earliest diagrams of kite records, which was published by that Observatory.

I have also much pleasure in placing upon the screen a reproduction of the records obtained when I was present on August 20th of this year from the deck of a steam tug near Crinan Harbour, off the west coast of Scotland, by Mr. Dines, in the course of the investigations to which I have already referred, as the third enterprise of the kind in which the British Association has taken part.

I now wish to return to the consideration of the measurements of humidity. This quantity is subject to very great irregularities of vertical distribution. As a general rule the percentage humidity of the air increases with height until the first cloud layer is reached; beyond that the air becomes dry, sometimes very dry, but humidity increases again to a second cloud layer and the process is occasionally repeated a third time, as illustrated by the Blue Hill diagram. When the apparatus passes into a cloud, saturation should be recorded by the instruments. In the earlier experiments this was not the case, as will be seen from the reference to Welsh's diagrams and Glaisher's tables. Glaisher also frequently speaks of the transition from dry fog to wet fog, but I think the dryness indicated in a cloud must be attributed to defective measurements of temperature, for any cloud, that is not merely of a transient character like the puffs of steam from an engine, must indicate saturation of the atmosphere. You will notice that saturation is indicated in the Blue Hill diagram where the kite passes into the clouds. In London it appears that we may really have dry fog, but fog in that case is a mixture of water particles with smoke and the products of combustion coat the globules of water and protect them from evaporation. In the clean air dry fogs cannot be accepted as reasonable. With kites the wire generally comes down loaded with condensed moisture when a cloud has been traversed. The registration of saturation when the balloon or kite passes into the clouds may be regarded, indeed, as a means of testing the instruments.

* As Dr. Shaw pointed out to the members during the reading of this paper, the idea of bringing the instruments to earth by means of a parachute was first devised by the Hon. Secretary of the Aeronautical Society of Great Britain.—ED.

I will not detain you longer by considering the measurements of radiation and atmospheric electricity in balloon voyages; measurements of electrical potential especially have contributed most materially to the recent almost phenomenal development of a satisfactory basis of explanation of the electrical phenomena in the discovery of electrons or charged ions and their properties. And with regard to the winds I will only say that it is clear from such observations as have been made that the cyclonic storms and variable winds which are the most conspicuous feature of our experiences are confined to a comparatively low stratum of the atmosphere above which the atmospheric currents are persistent and regular. I do not think that more conclusive evidence of the difference of meteorological experience at different levels can be cited than the case quoted in the Berlin reports, where a manned balloon and an unmanned balloon started together from Berlin. The manned balloon, with a south-easterly wind, made its way to Jutland, whereas the unmanned balloon, rising eventually to a height exceeding 60,000 feet, found an upper current and descended in the Balkan Peninsula.

The PRESIDENT: There are one or two gentlemen present who I daresay would like to take part in the discussion on this paper. Perhaps Dr. Scott, whose name we all know, would like to say a few words.

Dr. SCOTT: I have very little to say on the subject. I have not myself been witnessing any of these experiments. That curve of humidity through a vertical stratum of clouds is very curiously supported by some records which are given in Herschell's meteorology. There is a letter from Dr. Dalton giving an account of Peak Teneriffe, and how the guides explained that there were certain points at which it was not safe to lie down to rest, because they got into certain humidity; and this is repeated in Herschell's Meteorology. I think there is one thing, if you will allow me to say so, with reference to the President's address. I have always understood that there was very great difficulty in managing balloons as to the precise amount of weight that was carried, and if you had anything like the weight that was mentioned, letting loose explosives, or anything of that kind, over a town, the balloon would immediately mount and get completely out of hand by the mere fact of altering the amount of weight in it.

The PRESIDENT: It is now my pleasant duty to propose a vote of thanks to the reader of the paper, Dr. Shaw. We have all heard a very interesting paper to-night on a subject which is of great interest to all connected with meteorology and the investigation of the upper atmosphere. Some of these diagrams which we have seen are of great interest. I don't think it is necessary for me to make any criticisms on the paper. I only wish we could have heard some more remarks from those who have had experience in the matter of investigation. Unfortunately Mr. Dines has gone, and I do not know whether there is anyone else here who has taken the subject up. I will only ask you now to record your thanks to Dr. Shaw for his paper. (Applause.)

Sir HIRAM MAXIM: Ladies and Gentlemen.—If anyone is entitled to a vote of thanks here to-night, I think it is our old friend the President, Major Baden-Powell. (Cheers.) Certainly he has stuck to the thing with a great deal of enthusiasm, and after a long period of study I think he has learnt a great many new truths in connection with the subject that we all have nearest our hearts. I agree with him fully that the apparatus would be of enormous value to the Empire—if we had it. It is well known that it is within our reach, that the material is at hand to make it all, that the engines have already been developed to a sufficiently high degree of efficiency to make a flying machine; but it requires an enormous amount of money. In the experiments I made I spent fully £20,000. I should say, however, at the present moment if we had £100,000, and with such a clever engineer as Major Baden-Powell to conduct the experiments, that the Empire might possibly have a practical flying machine inside two years. I do not believe, however, that we shall use them for taking coals to Newcastle, I do not believe they will be used for the purposes of the Parcels Post, but rather for reconnoitring in time of war. They look to me as though they would be dangerous playthings at the best. During the last six months I have been troubled with bronchitis, and I am told by my physicians that I must get out of London any way, and, perhaps, out of England; and it has occurred to me that I might possibly get over my sore throat if I went back to my native country for a year or two, that is to the United States of America. And it is quite possible that I shall leave England and go to America, and while there I may conduct some experiments. It would be a very easy matter to get a large and level piece of ground in the State of Connecticut, or I might get an equally good place on Long Island. So I should not be surprised if, when you don't hear from me, I should be somewhere else, otherwise I am going to the States and may make some experiments on flying machines

and perhaps be back in two years. So I hope you will all join me in a vote of thanks to our very able President. (Applause.)

Mr. E. P. FROST: Ladies and Gentlemen,—It requires a very few words from myself at this late hour to support such an excellent proposal as Sir Hiram Maxim's vote of thanks to our Chairman, Major Baden-Powell. We are very pleased indeed to see him back amongst us again, and safe and sound, and it is my pleasure at this moment to second the vote of thanks proposed by Sir Hiram Maxim.

The CHAIRMAN: Well, Ladies and Gentlemen,—I need hardly say how thankful I am to you for the way in which you have received this vote, and I will not detain you much longer with any words from myself. I omitted to refer to Dr. Scott's remarks about dropping explosives from a balloon. I think he is quite right. I should be very sorry myself to go up in a balloon and drop any large quantity of explosive, because the balloon would ascend to a great height. I am almost sorry, I might say, to hear Sir Hiram Maxim talk of going away from England, because, of course, if he is going to make any experiments, we should like to know they were made in England and be there to see them. If he does go, we shall all wish him *bon voyage*, and we shall hope he will come back in his flying machine across the Atlantic. (Cheers.)

The proceedings then terminated.

The Cycala Flying Machine.

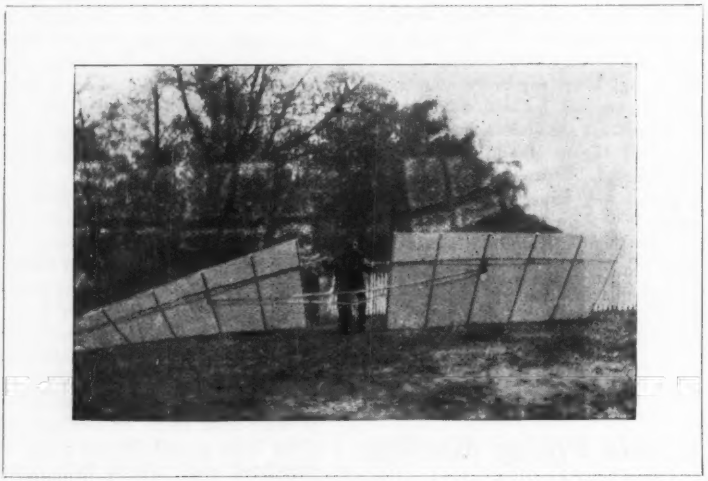
By DR. CHARLES ZIMMERMAN.

In my last communication to the Society it was stated that I had means by which I could vibrate my thirty-five-foot expanse of wing machine, that if it did not go, "I would try again." Well, it didn't go. Now, some one may say, "that was to be expected;" however, we can say, in rebuttal, that if hope did not burn brightly in the average inventor's breast, or his energy would fag in the effort to produce in material form his conception, or the unsympathetic attitude of his too conservative, yet esteemed contemporaries would cause him to desist, we would have no improvements, and progress would cease, except, perhaps, in the old beaten paths. It is far easier and much more pleasant to record and report success than failure. It is said that success is often the result of failure, but in the pursuit of the *ignis fatuus* of aëronautics, failure has been broadly written across all effort to wrest from the air that necessary grip and traction which will give us suspension and propulsion as does a marine vessel in water or an automobile on land.

The photographs herewith reproduced were taken by an amateur, and are rather deficient in detail; however, they will convey some idea of the general appearance of my machine. It consisted of a frame balanced on a bicycle wheel, and a wing, hinged near its middle on each end of the frame (Fig. 1). No tail was employed, dependence for longitudinal equilibrium was placed in the construction of wings, which will presently be described.

The frame to which the wings were hinged was three feet wide, *i.e.*, fore and aft, and 16 feet from side to side, the outer ends tapered to a point, and were elevated about four feet above the ground. The wings were each 16 feet by 7½ feet, pivoted by a universal joint near their middle on the tip ends of body frame, so that the operator sitting astride the wheel could vibrate the wings up and down, or move them back and forth, each wing independent of the other. In practice, however, it was found that we could not move the inner end of wings more than about three feet up and down on account of their striking the body frame near the wheel, whereas it was calculated to vibrate them at least six feet. The next difficulty was due to the wing construction, this consisted of ordinary unbleached sheeting reinforced by ribs of bamboo, a loop was secured to each rib about one-fifth the width of wing from front or leading edge, through these loops passed the arm; this arrangement permitted each rib to independently rotate vertically on the arm, as well as gave us a flexible wing in every direction. It was found that the wind striking the surface in front of the arm, just balanced that which impinged against the hinder part; we also got an equal lift all along the arm, no matter what its length. The body frame was hinged to the arm of wing, and in this manner the operator was suspended below the centre of pressure or support, which would automatically accommodate itself to the varying air pressure and currents, obviating the use of a tail for longitudinal equilibrium. It was these considerations which led me to try a construction of this kind, notwithstanding I was predisposed to a machine without moving parts. The balanced rib would rotate on the arm and the back end strike the ground, effectually preventing vibration as intended, except in a wind, when the wings were almost horizontal, in which case I could vibrate them sufficiently to

advance slowly into the breeze. I soon saw this was not the machine I wanted, as my ideal must go whether the wind is on or not. After several trials I finally detached one wing and anchored it as a kite as shown in photograph (Fig. 2). The wind at this time was about 20 miles per hour, and the operator is seen lifted, by being suspended from the arm, the outer rib is bent under wind pressure due to a cord to hold it steady. In another case the operator coasted down hill against a stiff breeze in which the ribs assumed approximately a horizontal position, and seemed to adjust themselves to the wind as was theoretically supposed. The experiments, as a whole, were disappointing; but we have gleaned a little from them, and will, as has been said, try again. The suggestions here offered may be of some benefit to others, and here, I may say that I am greatly indebted to my contemporaries and to those who have passed beyond the stage of action for their recorded experiments and observations, and as my experiences have been somewhat at variance in minor details, I will record one or two instances together with expectations. It would seem as though the supporting surface could be arranged to brace the framing, so that no wires, braces, etc., would be in evidence. I have long contemplated constructing an exaggerated form of concavo-convex surface; a deep concave will inhibit more air than a shallow one. The lift should far exceed the drift, and the deeper the concave, in proportion to its width, the more apparent this becomes. How would a concave three or four feet deep in a surface 10 to 12 feet wide, tapering to a plane at tail and wing tips, do? But how are we going to get it light in weight, smooth, strong and effective, and into shape that experiments can be satisfactorily instituted? This will be my next endeavour, and I think the first flyer will be motorless, the latter will be an adjunct after man-flight is a fact. In reference to superposed and following surfaces, if a slip of cardboard, say 3 by 12 inches is slowly vibrated back and forth in a still room in which smoke from a cigar is floating, it will be seen that the air is decidedly affected above and below, behind and before, several times the width of the cardboard, more so above and behind, than in front and below. This would seem to preclude any surface save only a single one-pair of wing machine.



The Cycala Flying Machine. (Fig. 1.)

In flying as a kite, the following surface is always depressed, when, as the single narrow wing sails approximately horizontal. In falling from an elevation the single surface sails twice as far as the double deckers or following surface models.

In reference to the concavo-convex wing surface, I am persuaded that the tendency for this shape to dip in front promotes propulsion, the flying body is balanced on a rolling trans-

verse column of air, and the least forward or backward movement of centre of support causes the body to tilt forward or backward, the forward motion prevents the back tilt to become more effective than to elevate the body. Propulsion here seems to be a state of unstable equilibrium. If this process can be controlled in a single pair of concavo-convex bird-shaped wings, our problem will be much simplified.

Many writers assert that the down stroke of a bird's wing is more rapid than the up stroke; and a bird, to elevate itself, beats its wings downwards. From my own observations carried on for a number of years, and after watching them closely and intently, it would seem that the wings are always positively inclined to plane of motion; this means that when a bird elevates itself by flapping its wings at an angle of say 80° with the horizon, that the plane of the wing is almost vertical and the wing-beats are horizontal. In flying horizontally the wind-beat is in direction from up and back to down and forward—that the down-beat occupies almost twice the time as does the up-beat—during the down-stroke the bird's body rises, and during the up-stroke it falls. It would seem as though wing and bird were united by a very elastic medium, and that the bird's body was constantly springing up and down, forcing the wings to always move in the contrary direction.

If an open umbrella is rapidly pushed up, the inrushing air at the end of the stroke will tend to carry it further up; if it is then slowly pulled down there will be a comparatively small depression on top of the same, due to the down rush of air at end of stroke. If these motions are reversed it will develop a most decided depression at the end of down-stroke. The inference in reference to bird-flight is apparent; the convex top at the end of a *slow* down-stroke cannot produce a depression equal to the concave bottom at the end of a rapid up-stroke which elevates.

If an open umbrella is held horizontally in a brisk breeze and a small column of smoke is

The Cycala Flying Machine. (Fig. 2.)

injected beneath, the smoke will rotate the whole width of umbrella in a direction similar to that of a wheel on the ground; this would indicate that the rolling transverse column of air referred to above is put in motion by the wing construction, and the upper half of this air is moving forward, incidentally pushing the surface forward. There are details of construction which I am prevented making public on account of being subjects for patents. There are pirates abroad waiting and watching, as soon as something is produced, they will appropriate it, and the inventor and investigator will never be known, much less rewarded, unless he first secures protection as far as possible. In this I am at variance with some. However, I think we can recall, if need be, recent instances in this connection.

At the present time the majority seem inclined to the combination of aëroplane and balloon as the final solution of the flying problem; we think, however, that if the various motors designed to push a gas-inflated envelope through the air were applied to simple aëroplane contrivances, we would much sooner arrive at a definite understanding of the matter.

In conclusion, we would say that no one as yet appears to be flying, and we seem to be as near it as any; and further, we see no reason why we should abandon our line of research, we will, therefore, endeavour to go a little further. Let our machine be an aërocurve with a pair of wings at an angle with tips up, a bird-shaped body, the latter to shield operator from head wind, and transform into lift what would otherwise be drift. The front edge of wings to be rigid compared with the back edge, yet the whole to be flexible so that a puff of wind on the side will have no more effect than to lift a portion of the wing without disturbing the whole system, the whole to be complete without moving parts; this includes the operator, who becomes an integral part, the life or motor of the machine—such a machine will depend for equilibrium and stability on its inherent flexibility and elasticity. The operator rocking transversely or back and forth, or springing up and down, should be able to propel it in a calm, and in a wind we should have sufficient power to transport ourself in any direction. Apply a motor to a construction of this nature and our conclusions would be much nearer being realised in a *bonâ fide* flying machine than with a stiff, rigid and unyielding apparatus for which we can find no counterpart in nature.

NOTES.

Message Balloons in Polar Expeditions.—The *Daily Chronicle* in September last gave an interesting account of the interview of Reuter's representative with Mr. Evelyn B. Baldwin, the leader of the Baldwin-Ziegler Polar Expedition, which has returned to Norway after 15 months' work in the North Polar seas. During the expedition fifteen pilot balloons were despatched, by means of which three hundred messages were distributed. To each of these balloons was attached a string of buoys which, by means of automatic contrivances, were released as they touched ice, land, or water. As the prevailing winds were north-easterly, it is likely that these balloons were driven on to the great ice field which last year blocked up the entire eastern coast of Spitzbergen to such an extent that no vessels were able to navigate, during the entire summer, the western waters of the Barents Sea. It is expected that as the ice drifts southwards along the eastern coast of Spitzbergen the buoys will be released, and when found will furnish valuable testimony concerning both air and sea currents. Every buoy is numbered, and contains a detail record of all conditions prevailing at the time of its being sent off. Every buoy is addressed to the nearest American consul, who will duly advise Mr. Baldwin of its discovery.

The International Balloon Ascents.—During April, May, and June last, twenty-one balloon ascents were made. France, Germany, Russia, and Austro-Hungary taking part in the experiments. The greatest height attained by the balloon-sondes was shown by the record of the balloon sent up from Berlin on May 1, when 19,564 metres were reached. The temperature on the ground was 6°·8; lowest reading during ascent, 58°·5. The next highest ascent is also recorded from Berlin, on June 5, when 16,750 metres were reached. Temperature on the ground, 18°·4; lowest reading, 58°·5. Next to this came the balloon sent up from Vienna the same day, when 10,480 metres were reached. Temperature on the ground, 15°; lowest reading, 62°·8.

The Fatal Accident to M. de Bradsky.—On October 13 last, M. de Bradsky and his engineer, M. Morin, perished in the Bradsky airship at Stains, near Paris, the ascent having

taken place at Vaugirard. The Bradsky air-ship was a cigar-shaped balloon 36 metres long and 6 metres in diameter, and had a cubic feet capacity of 850 metres. The airship was designed so that the balloon, the framework, and the passengers should be exactly equal to the ascensional power of the airship, the ascending power being furnished by means of a vertical propeller placed under the framework. On the fatal day, however, it appears that this balance was not perfectly attained, and that the airship had ascensional power from its hydrogen, apart from the action of the vertical screw. The framework was 22 m., 50 c.m. in length. It was constructed of steel tubes, and supported a car 5 m. long. It was suspended 3 m. 50 c.m. below the cover of the airship, and carried a petroleum motor of 16-horse power. At the back of the frame was the screw, which made 350 revolutions per minute. The rudder had 4½ square metres of surface.

Perhaps one of the most accurate descriptions of the ascent and consequent tragedy was that given by M. Aimé, and which appeared in the *New York Herald*, on October 14th. The balloon is described as starting off majestically under the joint lifting power of the hydrogen and the vertical propeller. It hovered for a minute or two over the Balloon Park of Vaugirard, and drifted little by little under the influence of the wind towards the Camp de Mars, the Invalides, the Place de la Concorde, and the Avenue de l'Opera. "As the air-ship advanced slowly up an altitude of two hundred metres, turning round and round as it went, sometimes advancing, sometimes moving backwards, swinging to port and starboard, in spite of the rudder, of which M. Morin held the tiller, and in spite of its propelling screw, under the direction of M. de Bradsky, it was only too easy for the spectators to perceive that it was drifting at the mercy of the wind. In reality, though the air-ship obeyed neither its rudder nor its propelling screw, it obeyed only too well the disastrous action of its ascensional screw, the perturbing influence of which would have sufficed to paralyse the effect both of the propelling screw and the rudder, even if the motor had been strong enough to resist the light breeze from the south west. The ascensional screw turning vertically under the car at the rate of five hundred revolutions a minute, made the air-ship swing round at the rate of about one turn per minute. Under these circumstances, the propelling screw and the rudder were powerless."

In M. Aimé's opinion what was necessary was a second screw turning in the contrary direction to neutralise this tendency to rotation.

On account of this rotation came the disaster, as M. Aimé points out from the Palace de l'Opera. It was plainly visible that under the influence of the vertical propellers the axis of the balloon obliged to turn by the resistance of the air ceased to be parallel to the axis of the car, and that in consequence the steel wires which fastened the car to the balloon underwent a tension which they could not withstand, breaking one after the other, with the fearful result that the framework parted from the ballon and fell to earth with the victims of the experiments.

The accident emphasises the necessity of more careful preliminary experimental work in designing novel aërial machinery. The action of the vertical screw on the balloon should, no doubt, have been first tested in mid-air by means of a balloon carrying no passenger. The twisting effect could then have been observed and corrected on a second experiment.

The Air-ship of the Brothers Lebaudy.—On November 13th, just one month after the disaster described above, the "Jaune," the navigable balloon of the brothers Lebaudy, made several successful return journeys in a calm atmosphere, though it is doubtful whether any advance was made in those journeys on the work of previous experimenters. The balloon is about double the size of that of M. Santos-Dumont, and carries a petroleum engine of 40 horse power. The length of the air-ship is 56 metres, 50, and it has a gas capacity of 2,284 cubic metres. The platform, constructed of bicycle tubing and steel piano wire, is 4 m. 80 long, and will accommodate three passengers. The two propellers are 2 m. 80 in diameter, and are placed at the side of the car.

Balloon Clubs.—It has lately been stated in public that the present Aëro Club was the first institution in this country to organise club balloon ascents. This is an error. Years ago there existed the Balloon Committee, established for the very same purpose for which the Aëro Club exists to-day. It comprised several famous amateur aëronauts, including Sir Claude de Crespigny, Sir Henry de Bathe, Colonel Templer, the late Mr. Powell, and the late General Brine, all of whom were ardent balloonists in the cause of pleasure and sport. Therefore, this country, years ago, set the example in the formation of balloon clubs, as it did in the formation of aëronautical societies. By all means let the rising generation have their ballon clubs, but in

their historical allusions let them not forget those who have piloted the way before them.

Aërography in Berlin.—Dr. Assman, of Berlin, contributes to the *Aeronautical Journal* the interesting and valuable information that for some months past the daily news from the higher atmosphere collected from kite observations appear in the *Reichsan-Zeiger* and several other leading papers. Up to now this has been done in no other place in the world except Berlin. Dr. Assman urges the importance of this work being also carried out in the British Isles where there are special advantages of frequent strong winds from our insular position.

The Exhibition of Balloon Photography.—In mentioning the excellent exhibits of balloon photography exhibited by the Rev. J. M. Bacon, to the recent Exhibition of the Royal Photographic Society, the Rev. F. C. Lambert makes a valuable and useful criticism on the arrangement of such aërial photographs at exhibitions. He points out that to get anything like the true and faithful reproduction of the original effect the picture should be so placed that it is looked down upon and not hung upon a vertical wall. At the Royal Photographic Society's Exhibition only in one case did the hangman think fit to comply with this important consideration.

REVIEWS.

The Greatest Flying Creature.

By S. P. Langley.

Reviewed by Major B. F. S. Baden-Powell.

The Greatest Flying Creature: by S. P. Langley introducing a paper on the Pterodactyl Ornithostoma, by F. A. Lucas, is a short, well-illustrated pamphlet dealing with this ancient and gigantic flying creature and its relation to modern birds and flying machines. From the fossil remains much has been learnt. The wing was evidently formed of a membrane stretched on the bones of the forelimb very like that of the modern bat. The beak was extremely large and sharp, probably with a small pouch like that of a cormorant. From many evidences it is concluded that it lived entirely on a fish diet, and that it flew long distances out to sea.

The comparatively small size of the breast bone, and, therefore, presumably of the thoracic muscles, would imply that it soared after the manner of an albatross rather than that it did much flapping of its huge wings. Actual measurements indicate a spread of wing of 20 feet. But it is supposed that its weight was not so great as might be conjectured for this expanse of wing. Mr. Lucas, estimating from a variety of considerations, puts it at under 30 lbs.

Some interesting tables are given to compare the supposed proportions of this animal with those of various existing birds, and also with Langley's model aërodrome. These show how, roughly speaking, the horse-power decreases proportionately to the size of the animal's weight and wing surface, that of the artificial model showing an enormously large proportion. Prof. Langley does not discuss at any length the inferences which may be drawn from this comparison. And if it be true that the weight of this creature was no more than that of some existing birds capable of flight, no very important lessons are to be learnt.

The Illustrated Scientific News.

Horace Marshall and Sons, London.

The latest attempt for the popularisation of science generally is the *Illustrated Scientific News*, the first number of which appeared in October last and which is to be published monthly. It ranges over a wide field, and from its variety should enlist the interest and support of the public. The opening numbers have been excellent throughout, both as regards the letterpress and the abundant illustrations. There is not a single page without interest to the general reader. Amongst the special articles which have already appeared is one by Major B. Baden-Powell, on the De Bradsky air-ship. The portraits of scientific celebrities which appear monthly are a feature of the new enterprise, and the January number contains the portrait of Sir William Crookes, F.R.S., the illustrious member of the Council of the Aëronautical Society of Great Britain.

The Dominion of the Air.

By the Rev. J. M. Bacon.—Cassell and Co., London.

The frequent accounts of aëronautical experiments which have lately appeared in the daily and weekly Press have done much to enlist general interest in aërial matters. Many of the public, however, have begun to want to know more about the problem of the mastery of the air than can be learnt in isolated articles. To such, "The Dominion of the Air," written by one who has often braved its perils, will

appeal. The book may be described as a popular history of aëronautics from the earliest efforts of Bacon and the Jesuit Lana, to the numerous performances of modern so-called navigable balloons. So graphically and pleasantly does Mr. Bacon treat the subject that the book before us can be read through on a railway journey of a few hours with the ease of a novel, and yet the reader will have imbibed a fund of information on the subject which he, perhaps, never possessed before.

We can confidently recommend this book to those who wish to obtain some entrance into aëronautical doings. The descriptions as a whole appear to be fairly accurate, which cannot be said of all books which claim to treat of popular science.

One error, however, must be noted. In chapter xxvii., speaking of the possibilities of balloons in warfare, the author remarks that these are now made of fragile material, and from the context it is presumed that the author means the British war balloons. The epithet fragile, however, cannot be justly applied to the envelope of the balloons manufactured at Aldershot by the Government. True the material—gold-beater's skin—in itself is fragile, but as several layers of gold-beater's skin are used in the construction of the war balloons the result is strength in the balloon envelope which in practice has been found to stand the wear and tear of military operations most admirably.

The illustrations in Mr. Bacon's book are abundant and well-selected.

Foreign Aëronautical Periodicals.

(In this list a selection of some of the more notable articles is given.)

L'AÉRONAUTE (Paris).

October, 1902.—Projet de ballon automobile (M. Josselin).

November.—Projet de ballon automobile (suite).

L'AÉROPHILE (Paris).

November, 1902.—Portraits d'Aéronautes contemporains: Henri Julliot (Edward Surcouf); L'Aéronat des Frères Lebaudy (Georges Besançon); La forme du ballon dirigeable (Jules Carelli); Croisières Aériennes (Henri Gaspard).

L'Aéronautique.—(No. 3, 1902). Ascension du ballon le Rêve bleu.

ILLUSTRIRTE AËRONAUTISCHE MITTHEILUNGEN (Strassburg).

October, 1902.—Uben den Zuschnitt von Ballonhullen (Prof. S. Finsterwalder in München); Luftballons, welche längere Zeit die nöthige Tragfähigkeit beibehalten können (Eric Unge); Die Freifahrt des Ballons "Schwede" am 29, 30 Juli, 1902 Die Gondelversuche im Wasser und der Unfall des Ballons Svenske (W. L. Moedebeck); Elektronen-Aspirationsapparat (Dr. Hermann Ebert); Ein Modellflieger nach Kress'scher Art (Arnold Samuelson).

WIENER LUFTSCHIFFER-ZEITUNG.

October, 1902.—Grundzuge der Praktischen Luftschiffahrt (Victor Silberer, VII. Die Langlung); Zur Explosion des "Svenske" (Gustave Trouvé).

December.—Grundzuge der Praktischen Luftschiffahrt (Victor Silberer, VIII. Die Schleifung); Graf Castillon de Saint-Victor; Der neue Kress'sche Drachenflieger; Der Ballon der Bruder Lebaudy; Zur Katastrophe des Bradsky.

Notable Articles.

Oct. 1902.
- 4. *The Sphere*.—"Some of the Latest Flying Machines."
- 14. *Lancashire Daily Post*.—"The Airship at Blackpool."
- 15. *Daily Telegraph*.—"Airship Disaster: Some Expert Opinions."
- — *East Anglian Times*.—"Travelling in Mid Air," lecture by Mr. Eric Stuart Bruce.
- 21. *Daily News*.—"Santos Dumont's New Airship."
- 23. *New York Herald*.—"Two Experts on Ballooning Trials."

Nov. — *L'Humanité Nouvelle*.—"La Navigation Aérienne."
- 12. *Times*.—"Mr. Bacon's Aëronautic Experiments."
- — *Daily Chronicle*.—"Sea Trip by Balloon."
- 15. *Illustrated Mail*.—"115 Miles in a Sea of Fog."
- 17. *Morning Leader*.—"Balloon Chase."

Dec. 6. *The Illustrated London News*.—"A Rival to the Balloon: The Kite in Warfare."
- — *Daily Graphic*.—"To Conquer the Air."—Sir Hiram Maxim's Views.

Applications for Patents.

(*Made in October, November, and December*).

The following list of Applications for Patents connected with Aëronautics has been specially Compiled for the AËRONAUTICAL JOURNAL by Messrs. BROMHEAD & Co., Patent Agents, 33, Cannon Street, London, E.C.

20642. September 22. GEORGE WILHELM MAY. **A New or Improved Aerial Ship.**

20973. September 26. JOSEPH YATES. **Aerial Motor Car.**

21363. October 1. HERBERT JAMES OWERS. **A Combination of Rudder and Propeller for Propelling Air-Ship or Boat.**

21500. October 3. ROBERT WALTER HUTTON. **An Improved Toy Air-Ship or Flying Machine.**

21535. October 3. CHARLES CADET. **An Improved Air-Ship.**

21680. October 6. HENRY MIDDLETON. **Improvements in Balloon Flying Machines or Helicoptera Aerodromes and Aeroplousts.**

22041. October 10. ADA MCDONALD. **Improvements in Machines for Navigating the Air.**

22123. October 11. FRANCIS ALEXANDER BARTON AND ANOTHER. **An Automatic Equilibrium Device for Air-Ships and the like.**

22733. October 18. SAMUEL FRANKLIN CODY. **Improvements in and connected with the Methods of and Apparatus for controlling the Travel of Carrier Kites.**

23713. October 30. HERMANN MUSCHEN. **Improved Driving Apparatus for Air and Water Vehicles.**

24336. November 6. LORD HOWARD DE WALDEN AND ANOTHER. **Improvements relating to Mechanically Propelled Aerial Vehicles.**

25723. November 22. CHARLES GOOMBRIDGE AND ANOTHER. **Improvements in Propellers for Aerial and Nautical Purposes.**

25934. November 25. HENRI ALPHONSE HERVÉ. **Improvements in Captive Balloons.**

26135. November 27. JOSEPH BARCLAY. **A Flying Machine.**

26225. November 25. EUGENE LINCOLN SWINGLE. **Improvements in Aeronautic Apparatuses or Flying Machines.**

26582. December 2. ALFRED CHIODERA. **Improvements in and Relating to Air Balloons.**

26832. December 5. SABATINO DI LAURO. **Airship.**

26893. December 5. FREDERICK HENTSCHEL. **Aerial Carriage.**

27027. December 8. WILLIAM COCHRANE. **An Improved Flying Machine.**

28155. December 20. CELESTE JOLY. **Improvements in and connected with Flying Machines and the like.**